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**Learning to Implement Enterprise Systems:
An Exploratory Study of the Dialectics of Change**

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Title: Learning to Implement Enterprise Systems:
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Abstract: This paper reports on a comparative case study of 13 industrial firms that had implemented an enterprise resource planning (ERP) system. Firms were compared based on their dialectical learning process. All firms had to overcome knowledge barriers of two types: those associated with the configuration of the ERP package, and those associated with the assimilation of new work processes. We examined the mechanisms through which firms attempted to overcome each type of knowledge barrier. We also observed different ERP implementation approaches: piecemeal and concerted. In the former approach, firms concentrated on the technology first and on process changes second. In the latter approach, both the technology and the process changes were tackled together. The learning challenges associated with each of these approaches were found to be different.

Keywords: Enterprise Resource Planning, Process Theory, IT Implementation, Dialectics of Change, Organizational Learning.

24 pages

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1. INTRODUCTION

Enterprise resource planning (ERP) software packages have become popular means for both large and medium-size organizations to overcome the limitations of fragmented and incompatible legacy systems. ERP systems are designed as an integrated set of software modules, all linked to a common database, handling a host of corporate functions such as finance, human resources, materials management, sales, and distribution (Slater, 1998). Most ERP packages also provide multiple language and currency capabilities, allowing operations in different countries to become more integrated. In an era of globalization, such characteristics are very appealing for organizations desiring to expand their activities worldwide without losing control over them. The popularity of ERP is evidenced in a recent study that showed that nearly 19 percent of organizations across all industry sectors have installed ERP software, with the manufacturing sector leading the trend (Computer Economics, 1999). The study also showed that the popularity of ERP continues to rise, with 34 percent of the surveyed organizations investigating, piloting, or implementing ERP packages. Davenport (1998a) characterized ERP as "the most important development in the corporate use of information technology in the 1990s" (p. 122).

The growing interest in ERP packages may be explained by their proclaimed benefits. ERP systems permit companies to implement fully integrated systems to replace their legacy systems, which are notoriously difficult to maintain because of their age, size, mission-critical status, and frequent lack of documentation. ERP systems are beneficial because they are integrated instead of fragmented, embed allegedly best business practices within software routines, and provide organizational members with direct access to real-time information (Ross, 1999b). ERP projects are often associated with fundamental organizational improvement efforts, such as business process reengineering (BPR). Because ERP packages support business integration, they potentially represent more than a change in technical infrastructure. Indeed, the main benefits resulting from an ERP installation may actually come from changes in the business processes, organizational structure, the roles and skills of organizational members, and knowledge management activities (Davenport, 1998b; Martin, 1998).

Realizing the high promise of ERP systems comes at a potentially high cost, as the transition to ERP is neither easy nor quick. The out-of-pocket costs of software, consultants and staff training are considerably higher for ERP than for most system implementation projects. It is common for companies to spend over \$100 million to implement an ERP system. Moreover, such investments are risky and many organizations adjust slowly to the inherent complexity of ERP software. ERP projects often experience out-of-control budgets (Schneider, 1999), and some critics believe that about half of ERP projects fail to achieve anticipated benefits because managers significantly underestimate the efforts involved in managing change (Appleton, 1997). Many well-known organizations, including AcroGroup (Marion, 1999), Nash Finch (Stedman, 1998b), Boeing (Stein, 1997), FoxMeyer (Diederich, 1998), Siemens (Seidel and Stedman, 1998), Panasonic (Zerega, 1998), and Bruno Magli (Stedman, 1998a), have failed to implement their ERP packages as they intended, either departing significantly from their original design specifications or missing project deadlines. The consequences of ERP project failures are considerable, given the millions of dollars and years of effort that these projects typically require.

In sum, high risks accompany the high payoffs potentially attainable through installing an ERP. The acquisition of an ERP package constitutes not only a large and complex technical endeavor for an organization but also carries the prospect of major changes in business processes and organizational structure. Given the growing significance of ERP in the current decade and beyond, it is essential that research focus on ways to improve the track record of ERP projects. Project risks must be reduced, and organizations must find ways to make the sizable investments in ERP software pay off. The research reported in this paper addresses these concerns. We

employed a comparative case study methodology to explore the processes by which 13 industrial companies implemented ERP systems supplied by a variety of vendors and supported by a variety of consulting companies. Drawing upon Van de Ven and Poole's (1995) theoretical analysis of organizational change, we viewed ERP implementation as a dialectic process that focuses on the interplay between forces promoting and forces opposing change. Our analysis focused specifically on the dialectic of learning and showed different ways in which the companies in our sample dealt with the knowledge barriers in ERP implementation.

2. PRIOR RESEARCH ON ERP

Although ERP enjoys wide coverage in the trade press, academic research into this new technology has only begun to appear. As a means to classify and critique academic research on ERP implementation, we used Mohr's (1982) categorization of research into variance and process approaches. A variance approach seeks to explain variation in outcome variables by associating outcomes with predictor variables. By contrast, a process approach seeks to understand outcomes by seeing how events occur over time.

2.1 Variance Research on ERP

The bulk of the emerging academic ERP research has adopted a variance approach, with the main goal of predicting outcomes of ERP implementation from an understanding of antecedent conditions (Markus and Robey, 1988; Mohr, 1982). Within this approach, two particular streams can be distinguished: studies of the factors that are critical to ERP success and studies of the impacts resulting from ERP. The former group of studies focuses on the antecedent conditions that predict or explain success whereas the latter group focuses on the variety of outcomes being predicted. Clearly, a complete variance explanation of ERP needs to include both antecedents and consequences of ERP, yet most studies to date tend to concentrate their interest on either one or the other.

2.1.1 Studies of ERP's Critical Success Factors

Despite the significant technical challenges posed by ERP, researchers agree that organizational factors are most critical to successful ERP implementation (Constantinos, 1999). Research on critical success factors tends to define success in one of two ways. First, success can be defined in terms of project characteristics: meeting project deadlines, working within budget, and sustaining a harmonious relationship among the various participants involved in ERP implementation. Although these are intermediate indicators of success rather than final outcomes, they are important because ERP systems have to be implemented before final outcomes can be realized. The work of several researchers investigating factors critical to ERP implementation success identifies the following factors as most common: top management support of the ERP project team and the implementation process, effective full-time project team staffed with top business and information technology (IT) people, and commitment to change throughout the organization (Bingi, Sharma and Godla, 1999; Brown and Vessey, 1999; Constantinos, 1999; Holland, Light, and Gibson, 1999; Parr, Shanks and Darke, 1999; Ross, 1999a; Sumner, 1999; Willcocks and Sykes, 2000).

A second way in which success is treated is to consider the value that companies generate from their ERP systems. Successful implementation does not necessarily ensure that firms will reap any long-term benefits, but certain factors have been found to be associated with business value. The factors that researchers have identified as key to generating benefits from an ERP include: a set of metrics that clarifies managerial objectives for the ERP, development of process expertise and structures for managing cross-functionally, and clearly assigned accountability for generating benefits (Deloitte Consulting, 1998; Ross, 1999a).

For the most part, studies of critical success factors offer few surprises. The factors in the first group, related to ERP implementation success, appear especially obvious and not clearly distinguishable from the outcomes of implementation success that they supposedly predict. Thus, these “findings” may be somewhat tautological. In addition, factors such as top management support and commitment to the project are not substantially different from factors that are critical to the success of most IT projects and to organizational change of other kinds. It is not clear how these studies contribute to a specific understanding of factors critical to the success of ERP projects, as distinguished from other types of projects. Moreover, the critical success factors in these research studies are not embedded in rich conceptual or theoretical frameworks. Neglecting theory is a serious omission because there is little general explanation of why the factors identified are critical to success. The studies, as a group, also manifest shortcomings in research design and analysis, thus limiting their value. Nonetheless, it is important to begin ERP research somewhere, and the factors identified are certainly identify likely areas of concern. However, subsequent research needs to incorporate a stronger theory base and to utilize more rigorous research methods.

2.1.2 Impacts Resulting from ERP

ERP impacts have not been documented extensively in the literature, mainly because ERP implementation projects at large firms extend over periods of several years. While some impacts are immediately apparent, others may be delayed. For example, some firms start to see improvements in their inventory levels and on-time delivery rates soon after implementation, but for many other firms the expectations for improved performance are not met even within the first year following implementation. Although some firms have reported measurable benefits (Deloitte Consulting, 1998), many of the impacts that have been reported are negative. Specifically, many firms have found that the quality of their data was poor (Eriksen, Axline and Markus, 1999; Ross and Vitale, 2000) and that users were unhappy with at least some features of the system (Koh, Soh, and Markus, 2000). Other research has identified contradictory impacts from ERP. For example, (Pawlowski, Boudreau, and Baskerville 1999) observed that a company adopting ERP produced greater job flexibility by expanding individual awareness, influence, creativity, and innovation. However, tightly integrated ERP systems were also more inflexible in many ways than the legacy systems they replaced. These findings support Davenport's (1998a) observation that ERP systems can empower users by equipping them with real time data, but that ERP systems also demand organizational discipline and strict adherence to standardized processes.

In contrast to the studies of factors critical to successful ERP implementation, the studies focusing on ERP impacts show no clear pattern of results. ERP systems are reported to have mixed effects within and across organizations. Unfortunately, studies of ERP's consequences tend to be descriptive and offer little in the way of theoretical explanation for the pattern of findings reported. Given the mixed and varied consequences of ERP, it is especially important to find or develop theories capable of explaining how and why ERP impacts occur. This is a difficult challenge for variance theories to meet because causal linkages between antecedents and outcomes are inferred rather than investigated directly (Newman and Robey, 1992). The next group of studies, which incorporates a process approach, offers greater potential to explain the divergent outcomes of ERP implementation. Rather than speculating on the connection between antecedents and outcomes, process research seeks a direct explanation.

2.2 Process Research on ERP

A smaller number of ERP researchers has adopted a process approach where the goal is to better understand how change actually emerges, develops, grows, or terminates over time (Markus and Robey, 1988; Van de Ven and Huber, 1990). In the process approach, ERP implementation may be conceived as sequences of discrete events that lead to outcomes of particular interest.

Alternatively, ERP implementation may be conceived as a sequence of stages, in which related activities occur. ERP researchers who investigate process have favored this second perspective. Researchers have described ERP transition with models having three (Deloitte Consulting, 1998), four (Markus and Tanis, 2000), and five stages (Ross and Vitale, 2000).¹

There are several common elements among these process models. Fundamentally, all three models recognize that firms have a planning stage where they make critical decisions about the purpose of and approach to ERP implementation. Firms then go through a project implementation stage which culminates in “going live.” This is followed by a stabilization phase where firms improve both systems and processes primarily to fix what is “broken.” Finally, firms go through one or more maintenance and improvement stages where they add functionality, reengineer processes, and perhaps seek business transformation.

Despite their focus on processes that explain ERP outcomes, stage models offer more description than explanation. Although descriptions of the various stages allow participants to anticipate future challenges, they do not provide an understanding of the nature of the underlying processes. By identifying and naming stages, it is possible to anticipate and/or track the issues that implementers must resolve, but it remains unclear why actions are effective or ineffective. Also, by adopting a stage approach to process modeling, research to date has not carefully examined the discrete events that occur during ERP implementation. As a family of theory, stage models of processes tend to assume that stages are arranged in a necessary sequence and that, consequently, all ERP implementations will proceed through the same stages in the same order. Such an assumption may or may not be valid. Indeed, the process models reviewed above tend to assume that organizational changes *follow* ERP implementation. Although this sequence may be manifest in the case studies supporting the stage models in the literature, it would also be possible to reverse the sequence of stages by changing an organization prior to implementing ERP. A strict sequence of stages, therefore, may not apply to all cases of ERP implementation.

The stage models reviewed above also share common implicit assumptions about the underlying nature of social change. Although they are based on different metaphors, the stage models all match what Van de Ven and Poole (1995) call a *life cycle* “motor.” A motor refers to the generative mechanisms contained within the entity undergoing change. According to life-cycle theory, “the developing entity has within it an underlying form, logic, program, or code that regulates the process of change and moves the entity from a given point of departure toward a subsequent end that is prefigured in the present state” (Van de Ven and Poole, 1995: 515). Although the connection to life cycle imagery may be unintended in the ERP process models, it is important for researchers to be aware of their implicit assumptions about change. If there are sound reasons to treat ERP projects as progressing through stages of a life cycle, then the choice of that motor is justified. However, alternative conceptions of the mechanisms underlying ERP implementation should also be considered.

In sum, prior research on ERP implementation and outcomes offers a starting point for future research. It is too early for prior research to have identified major controversies or gaps in our knowledge. To the contrary, our knowledge about ERP and its consequences has only just begun to accumulate. As our critique of the preliminary research suggests, research to date has been mostly descriptive. It has adopted both variance and process forms, but little attention has been paid to developing a compelling theoretical explanation of the changes associated with ERP

¹ Markus and Tanis (2000) and Ross and Vitale (2000) are two studies that were also mentioned in section 2.1, “Variance Research on ERP”, because these authors used both process and variance approaches within their work.

implementation. Within the process theory studies, attention has largely focused on descriptive stage models with an implicit life-cycle assumption. It seems appropriate, therefore, to investigate the ERP implementation process using other theoretical assumptions.

2.3. Toward a Dialectic of ERP Implementation

The research reported in this paper adopts a process theory perspective, but employs different assumptions about the mechanisms that generate change. In addition to the life cycle motor, Van de Ven and Poole (1995) offered three alternative types of motors that could drive organizational changes: dialectical, teleological, and evolutionary. Our particular interest is in the dialectic motor, which emphasizes a “pluralistic world of colliding events, forces, or contradictory values that compete with each other, for domination or control” (Van de Ven and Poole, 1995: 517). The dialectic interplay between two or more opposing entities was the basis for Robey and Boudreau’s (1999) proposed “logic of opposition” to explain the diversity of organizational consequences of IT, and dialectics could potentially explain the diversity of outcomes observed in ERP research. Using dialectics, researchers are not tied to a preordained sequence of developmental stages such as those represented in a life cycle model. Rather, any particular implementation project would be expected to manifest forces promoting change and forces opposing change. Rather than being determined by antecedent conditions, ERP consequences become largely indeterminate in a dialectic analysis. In this way, a variety of potential outcomes can be explained, at least retrospectively, with a dialectic motor. Because past research has revealed that changes induced by information technology are often resisted, unanticipated, or contradictory, a theory embedding a motor that acknowledges the opposing forces contributing to change promises useful analytical power (Robey and Boudreau, 1999).

In using dialectic analysis, it is necessary to identify the opposing forces (Robey and Boudreau, 1999). Identification of forces may be guided by an *a priori* choice of theory or it may be induced during data analysis. If a researcher, for example, wished to examine ERP implementation as a political contest, he or she could design research methods to identify opposing political interests. Alternatively, the researcher could operate in a more exploratory manner by looking for any evidence of opposing forces, not necessarily political opposition. In the method employed for this research, we selected dialectics as a motor believed to be useful for explaining a variety of outcomes for process research. However, we did not specify an *a priori* theoretical approach choosing to let the content of the dialectical theory be suggested by the research data (Boudreau and Robey, 1999).

3. METHOD

3.1 Sample and Data Collection

The research sample consists of 13 North American manufacturing firms or divisions that had implemented one of four major ERP packages. One of the authors interviewed 16 sites as part of a larger study of ERP implementation (Deloitte Touche, 1998). To be included in the study, a company needed to be: (1) a North American-based manufacturing firm that had (2) completed a major implementation of ERP software from SAP, Oracle, Baan, or PeopleSoft, and that (3) included manufacturing as well as other modules. The original sample was also designed to include only firms with revenues exceeding \$500 million, but that criterion was later relaxed in order to include more companies adopting ERP solutions from vendors other than SAP. The interviewer independently solicited three of the sites because of their known interest in ERP research. The research sponsor, Deloitte Consulting, and Benchmarking Partners, a business research firm, selected the remaining firms based on prior knowledge of their ERP efforts. Both Deloitte and Benchmarking had extensive knowledge of the North American ERP market and had close contacts with ERP vendors. Three of the 16 firms had insufficient data to allow analysis for

this study, so 13 firms were used for this research. Characteristics of firms in the sample are described in Table 1.

Table 1. Sample Firms

Company	Revenues	ERP Vendor	Project Budget	ERP Modules Implemented
AutoCo	\$12 B	SAP	\$110 M	Fin, Sales, Mfg, Supply Chain
CommCo	\$450 M	Oracle	\$18 M	Fin, Sales, Mfg
ComputerCo	\$13 B	SAP	\$400 M	Fin, Sales, Mfg, Supply Chain
ContainerCo	\$3.5 B	PeopleSoft	\$100 M	Fin, Sales, Mfg, HR
EquipCo	\$125 M	Baan	NA	Fin, Sales, Mfg
HealthCo	\$2 B	SAP	\$30 M	Mfg, Supply Chain
IndusCo	\$5 B	SAP	\$130 M	Fin, Sales, Mfg, Supply Chain
MetalCo	\$125 M	Baan	\$2.5 M	Fin, Sales, Mfg, Supply Chain
PharmaCo	\$2 B	SAP	\$13.4 M	Fin, Sales, Supply Chain
PlastiCo	\$2.5 B	SAP	\$87 M	Fin, Sales, Mfg, Supply Chain, HR
TeleCo	\$1.2 B	SAP	\$30 M	Fin, Sales, Mfg, Supply Chain, HR
TextileCo	\$1.5 B	SAP	\$30 M	Fin, Sales, Mfg, Supply Chain
WearCo	\$550 M	SAP	\$14.7 M	Fin, Sales, Mfg, Supply Chain

Data collection consisted of structured telephone interviews with three persons at each company: a project sponsor, a project manager, and a line manager whose operations had been affected by the implementation. Due to difficulty in contacting potential respondents, all three interviews were completed at only nine of the 13 firms. Two interviews were conducted at three of the remaining firms and one interview was conducted at the other one. Interviews were conducted in August and September 1998.

The interview protocol asked questions about the scope of the implementation, the motivation for the implementation, outcomes, major challenges and issues, and future expectations. The interviews lasted one hour and were not tape-recorded. Immediately following each interview, the interviewer wrote a detailed summary from notes taken during the interview. The interviewer included quotes or near-quotes in the summary but did not work from a recording or transcript of the interview.

3.2 Analysis

The two authors who were not involved in data collection each analyzed all of the interview reports. They examined each case for evidence relating to the company's motivation for the ERP project, the process of ERP implementation, outcomes, and future plans. This evidence was summarized and entered into a matrix created for the purpose of intermediate qualitative data analysis (Miles and Huberman, 1994). The format for the matrix is shown in Table 2. For each case, the authors recorded information about antecedent conditions (e.g., company demographics, project motivation), the implementation process (e.g., overcoming obstacles, dialectical forces, sequence of events), and outcomes (e.g., resulting benefits, future endeavors). Each of the two authors prepared an analysis matrix for each company. They then met to combine their matrices into a single matrix, resolving all discrepancies between each other's entries through discussion and references back to the interview reports. The resulting combined matrix was then used to identify commonalities and contrasts among the cases.

Table 2. Evidence Included in the Intermediate Analysis Matrix

Type of Evidence	Information Captured	Examples
Antecedent Condition	Demographic	Description of the company. Description of the ERP project.
	Motivation	Motivation for implementing an ERP.
Implementation Process	Process of overcoming barriers to implementation	Success and difficulties in overcoming obstacles to ERP implementation. Issues posed by ERP implementation.
	Dialectical forces	Dialectical forces at play within the process of the ERP implementation.
	Sequence of events	Timing of ERP implementation relative to changes in organizational processes. Timing and extent of customization of the ERP package.
Process Outcome	Resulting benefits and problems	Outcomes resulting from ERP implementation.
	Future endeavors	Expectations following ERP implementation. Plans for upgrades and future modifications.

RESULTS

4.1. Motivations for ERP Implementation

Using the different rows of the analysis matrix, we sought contrasts among groups of companies based on their antecedents, processes, and outcomes. Comparing antecedent motivations revealed seven distinct reasons for pursuing ERP, summarized in Table 3. The most common motivations for implementing ERP systems were to make systems “Y2K compliant” and to replace legacy systems. Clearly, these two objectives can overlap, although each was mentioned separately as a distinct motivation. The pressure in the late 1990s to become Y2K compliant can be considered a unique and temporary motivation, although many companies used the excuse of Y2K to address more enduring needs. The most common of these was including ERP as part of a wider process reengineering initiative and integrating disparate sites and/or operations. Several of the firms had acquired or merged with other firms, and they sought to implement standard business processes across sites, especially global sites, so that operations could become integrated. Standardization and integration are similar to another objective, supporting corporate growth, which was cited as a motivation by three companies. The only other motivations mentioned were the general desire for improved reporting and decision making, and a need to comply with a specific regulatory requirement. The total frequency count exceeds the size of the sample (13) because many companies had multiple motivations, as shown by the multiple entries in the second column of Table 3.

Table 3. Motivation for Implementing an ERP

Motivation (frequency)	Companies
Y2K compliance (7)	ComputerCo, ContainerCo, TextileCo, AutoCo, CommCo, HealthCo, MetalCo
Legacy system replacement (6)	EquipCo, WearCo, PlastiCo, IndusCo, CommCo, PharmaCo
Process reengineering initiative (6)	ComputerCo, IndusCo, ContainerCo, PlastiCo, PharmaCo, MetalCo
Integration or consolidation of multiple sites and/or operations (4)	TeleCo, ComputerCo, TextileCo, CommCo
Support growth and/or acquisitions (3)	CommCo, IndusCo, WearCo,
Improve reporting and decision making (1)	ContainerCo
Regulatory compliance (1)	HealthCo

Companies with similar motivations were grouped together to see if associations could be made between motivation and either process or outcome. However, no clear relationship was seen between the motivation for pursuing ERP and the processes used or the outcomes realized. The different reasons for implementing an ERP did not appear to result in different implementation processes or outcomes.

4.2 Outcomes of ERP

Grouping companies by outcomes proved to be more difficult, mostly because many of the companies were still experiencing near-term, post-implementation adjustments. Respondents described a mixture of positive and negative impacts resulting from their ERP implementation, but most said that it was “too early to tell” what ultimate benefits might result. Performance improvements included greater efficiency within supply chains, improved financial accounting, greater data visibility and analysis capability, and more process-centered thinking. Negative outcomes included problems of data inaccuracy, loss of reporting capabilities, resistance by users, strained relationships with customers, and loss of skilled people. Indeed, almost every case exhibited some combination of positive and negative outcomes, making our goal of assessing those outcomes difficult. Post-implementation dips in performance are understandably common after ERP systems “go live” (Markus and Tanis, 2000; Ross and Vitale, 1999), and the respondents in our sample were candid about both benefits and problems. They expressed hope that more substantial benefits would result once the adjustment period was over, but we had no way to gauge their ultimate success with their ERP.

4.3 ERP Implementation Process

Given the mixed antecedents and unstable outcomes among firms in the sample, we decided to focus more directly on the process of implementation. Our choice of using a dialectical perspective to study the data focused our attention on the nature of obstacles encountered during implementation and the manner in which obstacles were overcome. A variety of theories potentially supply the constructs that operate in dialectical fashion (Van de Ven and Poole, 1995;

Boudreau and Robey, 1999). For example, theories of organizational politics explain organizational change with reference to the social power of opposing interest groups which engage in political activity to pursue their separate agendas. In the context of ERP, politics might be useful to explain the resistance by plant managers to a system that imposes standard processes on their local operations. The implementation barriers encountered in a political analysis might be overcome through negotiation and bargaining, or by the assertion of power. Those favoring ERP and those opposing it would thus be engaged in a dialectic process that produced the outcomes realized at a future date.

Although politics and other theories, such as organizational culture and institutional theory, all incorporate a dialectical “logic of opposition” (Robey and Boudreau, 1999), the respondents in our study made little mention of political motives or actions. Rather, aside from brief mentions of organizational culture, most of the language used reflected a concern with learning and knowledge. To respondents, the primary obstacle to implementing ERP successfully and realizing benefits from new business processes was the firm’s established knowledge pertaining to systems and business processes. In the language of organizational learning, existing “organizational memory” was seen as a barrier to acquiring new knowledge (Bowker, 1997; Hedberg, 1981; Klein, 1989; Robey, Boudreau and Rose, 2000). Managers trying to comprehend ERP systems and new business processes enabled by ERP needed to reconcile the demands for new knowledge with their knowledge of old systems and procedures. To explore the role of organizational learning in ERP implementation, we conducted a detailed analysis of the cases based on this dialectic conception of organizational learning.

Barriers to learning ERP were mentioned frequently. For example, at CommCo, a respondent said that instead of learning the new processes that the firm was trying to introduce, individuals worked to reestablish “how to do what they had done in the past, including workarounds.” Another respondent from AutoCo remarked that users were adept at working around the requirements of ERP software. In his opinion, the practice of pulling data off the system for analysis on desktop software instead of querying the ERP database directly was a crucial workaround with potentially disastrous results. “Microsoft is the toughest legacy system to replace,” he said. In order to decrease the reliance on established organizational memory, HealthCo hired college students, who “learn easily because they’re not constrained by the old way of doing things.” In contrast to workers who knew the old processes, student recruits would not need to unlearn the way things were done in the past. Respondents noted that the obstacles to learning new systems and processes were not simply resistance to change. Rather, individuals struggled with understanding how to do their jobs. For example, a PlastiCo respondent noted that practicing on sample data did not prepare employees for the implementation. “It’s like turning out the lights; people didn’t know where they were going.” Several respondents observed that it was difficult for individuals to understand how their actions affected other people in the organization. For example, at WearCo, factory workers could not understand the benefit of entering data that had no use within the factory. Some firms tried to change reward systems to motivate learning of new systems and processes. At IndusCo, line managers had formerly been rewarded for achieving bottom-line results, regardless of the methods used. With the new ERP, many tried to achieve these results by “beating the system,” a behavior learned during the legacy system years. With their ERP system, however, rewards would be bestowed on those who exercised discipline instead of creativity. This led one IndusCo respondent to remark, “These guys [line managers] have a lot of unlearning to do, and it’s painful.” WearCo also recognized this issue and offered incentives to plants that used the ERP system accurately. In a number of cases, respondents not only commented on learning requirements, but they also made reference to dialectical forces at play. Perhaps the most direct such reference was to the “countervailing forces” at PlastiCo. Many companies also acknowledged the tension between expending efforts to get an ERP system up

and running and the ongoing obligations of running the business. TeleCo, ComputerCo, PlastiCo, AutoCo, and PharmaCo all made explicit mention of the conflict between learning the new world of ERP and extracting business benefits from existing systems. In essence, these firms saw major tradeoffs between acquiring new knowledge and exploiting what they already knew. In summary, respondents described organizational forces that promoted learning about new systems and processes as well as forces that sought to maintain the status quo.

4.3.1 Overcoming Knowledge Barriers

According to respondents, ERP implementation challenged established knowledge in two ways. First, the software was prepackaged, allowing for customization only through tables that the firm could *configure* in order to reflect its business rules. This changed the thrust of the implementation process. Whereas prior systems implementations started with an understanding of how management wanted to change existing processes, the starting point in the ERP implementation was an understanding of the software and how to configure it. Because the software was very complex and highly integrated, this was a formidable learning task. Second, as firms replaced existing legacy systems with an ERP, they disrupted the processes that were built on those systems and replaced them with more standardized, cross-functional processes. This meant that firms were not merely introducing new systems capabilities; in most cases they were also attempting to *assimilate* a new management structure and new management processes into the organization. Our analysis focused on how firms attempted to overcome both configuration and assimilation knowledge barriers. The data revealed that many of the firms took specific actions to help them overcome knowledge barriers, as shown in Table 4 (parts a and b). Firms were categorized as either “more successful” (4a) or “less successful” (4b) in overcoming knowledge barriers associated with both the configuration of the package and the assimilation of new work processes. Only two cases (PlastiCo and ContainerCo) had mixed results, in that they were judged successful in configuring ERP but less successful in assimilating new work processes.

Table 4

Firms Classified by their Relative Success in Overcoming Knowledge Barriers

4a. Firms that were more successful in overcoming knowledge barriers	
TeleCo	Best people on core team; moved from site to site. Consultants phased out before implementation was complete but expected to help out with upgrades. Training on new processes as well as system. Employee incentive plan linked to performance metrics.
HealthCo	15% of project budget allocated to formal training. Core team of 10 people who stayed together; core team rewarded for early completion. Retention plan for ERP-experienced employees. Job rotation.
MetalCo	Emphasis on training. Core team rewarded for early completion. Incremental approach to implementation. Presidential support for project. Motivation to learn as fast as possible to be autonomous from consultants.

PlastiCo	2% of project budget allocated to formal training. Cross-functional core team of “best” people. In-house training (i.e., skills), but insufficient education (i.e., understanding of the business). Overcame inertia among users. No system integrator but consultants hired by core team to support their efforts.
ComputerCo	Consultants in the “driver seat.” Incentives to retain knowledgeable employees. Ran legacy systems in parallel for 6–8 months. Change management training. Incremental upgrade strategy. Core team camaraderie.
TextileCo	20% of project budget for training. Addressed culture change. Effective consulting relationship.
IndusCo	20% of project budget for training. Learned from prior implementation sites. Effective consulting relationship. Change management training.

4b. Firms that were less successful in overcoming knowledge barriers	
CommCo	1% of budget for training, ineffective. Inability to recruit people who knew the software. Only 4 of 20 project team members stayed with users. “Textbook” change process. Users worked around system requirements.
WearCo	Large project team, including IT, consultants and business users. Project team turnover. Lack of interest in training. Work became more complicated. New work processes circumvented.
AutoCo	10% of budget for training. Lack of resources to measure system impact. Overly dependent on consultants. Process team was only 6 people. ERP costs charged to divisions. Divisions selected only the modules they wanted.
EquipCo	Did not listen to consultants’ advice. Minimal formal training. Small core team.

ContainerCo	Between 3% to 10% of budget for training. Knowledgeable employees were not retained. Insufficient technical expertise in-house. Strong implementation team, including functional experts, subject matter experts & consultants.
PharmaCo	5% training budget. Overly dependent on consultants. Core team limited in size and lacked international focus.

4.3.1.1 Overcoming Configuration Knowledge Barriers

Prior to ERP implementation, every firm had to configure its packaged software in order to specify the business rules that would constrain organizational decision making. Configuration involved populating at least hundreds, and usually thousands, of tables with business rules. To succeed in configuration, a firm had to understand the capabilities and limitations of the software and be able to describe the business processes that would be supported by the ERP. The complexity of the ERP software packages created significant knowledge barriers that were readily acknowledged by the respondents in the interviews. Firms overcame configuration knowledge barriers by using core teams and consultants. Successful firms set up *core teams* that were charged with responsibility for configuring the ERP system to the firm's processes. In dialectic terms, the core teams operated as forces promoting new knowledge against the forces of existing organizational memory, which acted as knowledge barriers. Core teams were critical to achieving configuration, and the most successful companies found ways to reward the teams and keep them energized. The teams at HealthCo and MetalCo received large bonuses for completing configuration significantly ahead of schedule and under budget. Respondents at ComputerCo reported high camaraderie on the core team. At TeleCo and PlastiCo, the "best people" were placed on the core team. TeleCo's core team moved from site to site during implementation, facilitating the spread of obtained knowledge. PlastiCo's core team was described as being "on a roll, kicking butt," and their enthusiasm was reflected in the motto "Get on the [ERP] train or get under it."

By contrast, most of the less effective companies used small core teams or experienced high turnover on the team during and after the configuration process. Where core teams were small, as they were at both A-Dec and AUTOCO, critical knowledge did not develop or spread through the organization. At PharmaCo, the core team failed to make much headway in rolling out ERP to international sites because the team lacked international representation. "People thought we were about as helpful as a hemorrhoid," suggested one respondent from PharmaCo. Even larger core teams became less effective when they experienced turnover. WearCo's core team included 20 people, but they experienced difficulty because of high turnover. At CommCo, only four of 20 project team members became the envisioned "super users," who were supposed to support ERP efforts following implementation. The rest either left the company or went back to their previous positions. As a result, respondents at CommCo concluded that they did not have "as much system and organizational knowledge supporting the systems as needed." In some cases, core teams were assembled to meet the challenge of managing user reaction to ERP, but they lacked sufficient technical knowledge about configuration. Although ContainerCo's core team was described as "strong" and consisted of "functional and subject matter experts," they admitted to lacking the sufficient technical expertise in-house to overcome the configuration knowledge barriers.

The second mechanism that firms used to overcome configuration knowledge barriers was to hire *consultants*, who brought external software expertise gained through formal training and prior experience. Consultants applied their knowledge either by configuring the software themselves or

by working with the firms' core teams. For example, a TextileCo respondent described its consultants as "a crackerjack team that did a super job on the technology." The more successful companies consistently reported an effectively managed relationship with their consultants. Dow ContainerCo and TELECO both brought in consultants to help them address specific problems and then let them go. TELECO's consultants were "phased out" before implementation was even completed, but TELECO expected to call them back to help with software upgrades. Even where consultants were regarded as being in "the driver's seat," as they were at ComputerCo, respondents noted that they were able to avoid over dependence and ensure knowledge transfer. Thus, in the successful cases consultants played a key role in transferring external knowledge to the organization but that role was carefully managed by the client firms.

In the less successful cases, companies either depended too little on consulting advice or became over dependent. EquipCo did not listen to the advice from their consultants and ignored specific cautions against heavy customization during software configuration. "We tried a few [consultants] but they said things we didn't want to hear, so we sent them away," reported an EquipCo respondent. Only later did EquipCo realize deficiencies in the work processes that the software had been customized to fit, so they actually had to change their business processes and re-customize the software. Over dependence on consultants was reported by both AutoCo and PharmaCo. The respondent from PharmaCo reported that the company was like "the baby at the mother's breast," unable to take care of its own needs while becoming totally dependent on the consultants. At PharmaCo, 60% of the project cost was paid to consultants.

4.3.1.2 Overcoming Assimilation Knowledge Barriers

The second kind of knowledge barrier is associated with the assimilation of new work processes. Assimilation is a challenge not only for users but also for core team members and other stakeholders such as customers. Before users can effectively use an ERP system, they must learn to appreciate its implications for their work and learn how to perform any new business processes resulting from system implementation. Firms addressed the need for users to learn new systems in two ways. First, they provided formal training for users on at least the new systems and in some cases on the new processes. Second, they took an incremental approach to systems implementation.

Both the more successful and the less successful firms cited *user training* as a key requirement for ERP implementation. However, firms differed in the kind and amount of training they provided. At PlastiCo one respondent distinguished between the "training" that was designed to teach users the procedures for using the new system, and the "education" that was also needed to teach the users new business processes. Users received training on the system at all firms, but the more successful firms offered education on new processes. Several firms, including ComputerCo and TextileCo, extended their educational efforts to include change management. ComputerCo's user respondent repeatedly emphasized the importance of change management, described as a series of workshops designed to ensure that people met their performance objectives. "Don't underestimate the change management work. This is big," he reported. At TextileCo, ERP implementation was regarded as "massive cultural change," and a portion of their large training budget (20% of project budget) was allocated to address "organizational / cultural change."

For the sample as a whole, training budgets ranged from one to 20 percent of the total project budget. At CommCo, which spent only one percent of their project budget on training, the culture was described by one respondent as based on the principle of "just do it and get it done." In this context, training was not valued. Respondents reported that when training was complete, "we looked at each other and said, 'we're trained,'" but it was clear that the users had not learned what

they needed to know. Although some change management material was included in CommCo's training, it was considered at "too high a level" to be useful to users.

Although ERP is often associated with radical change, our results suggest that user knowledge barriers were overcome more effectively when change was introduced *incrementally*. A respondent from MetalCo explained that, "you can't weight lift at the same time you replace your nervous system." For MetalCo, replacing the nervous system came first, followed by a slowly paced redesign of business processes. Firms looked for ways to "break up" the huge implementation effort by choosing one site at a time or by limiting the number of modules they implemented initially. An incremental approach allowed project participants and users to recover from the stress and strain of implementing an ERP. While respondents generally acknowledged the hard work accomplished by core teams and user groups, the risk of burnout was always present. As a respondent from PlastiCo remarked, "It's all very exciting as long as no one goes postal." The more successful firms introduced incremental changes in a variety of ways. PlastiCo, AutoCo, and IndusCo sent a single core team to each of its sites so that they could leverage the learning from each implementation. ComputerCoss ran their legacy system in parallel with the ERP for 6-8 months and upgraded the software on a continuous basis, taking "small bites instead of a big one," according to one respondent. These efforts provided members of the organization with time to learn new processes.

In sum, the success in overcoming knowledge barriers differed across companies. Where companies supported the core implementation team and managed their relationships with consultants well, they succeeded in overcoming knowledge barriers related to the configuration of ERP software. Where they invested wisely in training and adopted an incremental approach to organizational change, they dealt more successfully with the assimilation of their ERP.

4.3.2 Piecemeal and Concerted Change Processes

As stated earlier, our examination of the implementation process included looking at the order of events during implementation (see Table 2). Prior studies have adopted the stage approach to defining organizational processes without looking at the sequence of discrete events. We wished to see if the timing of two major events, implementing ERP and implementing changes to organizational processes, affected learning. One possible approach is to concentrate on implementing the technology first and focus later on process changes. Miller and Friesen (1982) referred to this type of change as *piecemeal* because fewer changes are undertaken at one time. It may also be considered an example of loose coupling between technical and organizational change (Mitchell and Zmud, 1999). The second possible approach is to simultaneously undertake the ERP implementation and changes to business processes. In this approach, members of an organization must not only learn to use new systems, but they must also learn new ways of performing their jobs. This type of change has been called *concerted* change (Miller and Friesen, 1982) because more things change at once, and it is an example of tight coupling between technical and organizational change (Mitchell and Zmud, 1999).

The distinction between piecemeal and concerted change is different from the distinction between incremental and radical change (Miller and Friesen, 1982). The latter distinction refers to the pace of change, that is, how rapidly changes of any kind are introduced. Firms may proceed at either an incremental or rapid pace whether they are pursuing a piecemeal or a concerted change approach (Miller and Friesen, 1982). Because companies pursuing loosely coupled, piecemeal strategies for implementing ERP may face different learning challenges than those pursuing tightly coupled, concerted strategies, we divided the sample into two groups in order to analyze similarities and differences in how they addressed knowledge barriers.

The eight companies that adopted a piecemeal approach (TeleCo, HealthCo, MetalCo, WearCo, PlastiCo, CommCo, AutoCo, and EquipCo) implemented ERP either prior to or apart from a business process reengineering initiative. They considered the ERP implementation as primarily a systems replacement effort and intended to defer the reengineering of their processes. For the most part, these firms viewed the ERP implementation as primarily installing a packaged software system on a client/server platform to replace a patchwork of incompatible legacy systems. Typically, these firms sought to install a “vanilla” version of the ERP software with customizing through configuration rather than modifying the program code. At one firm (EquipCo), however, the commitment to avoid reengineering was so strong that management modified the ERP package in order to make it conform closely to existing organizational processes.

The remaining five firms (ComputerCo, TextileCo, IndusCo, ContainerCo, and PharmaCo) pursued a concerted change approach, focusing on business process redesign along with ERP implementation. In most of these companies, ERP was seen as a component of a larger reengineering or transformation initiative. For example, at TextileCo, teams of employees had reviewed 500 as-is processes and designed 300 new processes prior to configuring the ERP package. ContainerCo had redesigned its supply chain processes, and PharmaCo had determined a set of processes that would be standardized across its 13 sites. In attempting to change systems and reengineer business processes simultaneously, the concerted firms took on a more ambitious task than that of the piecemeal firms.

Firms that adopted a piecemeal approach would seem to have an easier time overcoming knowledge barriers than firms that adopted a concerted approach. By limiting their initial efforts to a system implementation, they allowed management to focus resources on one, rather than two, major organizational change. PlastiCo’s piecemeal implementation was undertaken with the recognition that a more concerted effort might further exhaust the organization, which had already experienced “constant deadlines and the dual responsibilities of implementing [ERP] and running the business.”

In deferring the learning, however, these firms also deferred much of the benefit they expected to generate from their ERPs. When asked about their future plans, most of these respondents confessed that the real challenges lay ahead, when their companies would begin leveraging their ERPs to produce greater business value. In fact, they had implemented a few required process changes at the time of implementation, but most felt that achieving the potential benefits of an ERP would require more extensive attention to process reengineering in the future. Some respondents were apprehensive about the prospect of deferring process changes because they recognized that configuration decisions made in the present would limit longer-term options for process changes. A respondent from AutoCo explained that an ERP system was like poured concrete: “Both [ERP and concrete] are easy to mold when first put in, but nearly impossible to change after the fact.” Thus, firms in the piecemeal ERP group had not simply deferred part of their task to the future; in some cases they may have increased the total learning challenge as a result of this approach.

Despite their desire to defer learning, firms adopting a piecemeal approach discovered that ERP dictated some immediate changes in business processes. For example, ERP systems required working more cross-functionally than before simply because of their integrated design. Thus, even firms adopting a piecemeal approach found themselves implementing new systems and some new processes simultaneously. In no case was a firm able to focus exclusively on a systems implementation.

The one firm (EquipCo) that attempted to circumvent process change by customizing and changing program code to make the system fit its existing processes experienced extraordinary technological problems as a result of its modifications. System performance was so poor even 18 months after implementation that EquipCo had to limit the number of users on the system at one time. In addition, it was clear that the processes that had been designed into the system failed to leverage the capabilities of the ERP and severely limited the firm's ability to use the data effectively.

By contrast, firms pursuing a *concerted* change approach took on the challenge of changing systems and processes simultaneously, which created greater learning requirements. Typically, they designed their new processes prior to configuring the system but implemented those processes as they implemented the system. They faced the risk that the software might not support a new process as designed, but their greater challenge was in the amount of learning required to implement new systems and new software simultaneously. In fact, the challenge was so daunting that all five firms eventually succumbed to some practices that nearly mimicked the behaviors of firms that professed to take a piecemeal approach. For example, although PharmaCo intended to introduce process reengineering while implementing the ERP, one respondent from PharmaCo estimated that it could take about three years to get full knowledge of the software: "At first, you use about 15% of [the ERP's] functionality, but over time, you find more and more useful capabilities." At ContainerCo, functional managers were expected to use the ERP to redesign their business processes. However, ContainerCo actually implemented its ERP modules into traditional functional departments, foregoing the advantages potentially associated with process integration. By leaving the design of potentially integrative changes such as supply chain management at the discretion of the business units, ContainerCo faced significant future issues. As a ContainerCo manager said, "They did the redesign on paper and said they would change, but it's another thing to really do it."

All of the firms pursuing a concerted approach had long traditions of business unit autonomy, and ERP was regarded as dismantling not only existing business processes but also the understanding of how work ought to be structured. At PharmaCo, the "culture of autonomy" was seen as a threat to standardizing business processes across divisions. Although standard business processes were part of the corporate model for the first ERP implementation, fears were that divisions would modify their individual processes later. At TextileCo one respondent told the story of a division manager who purportedly argued: "No goddamn computer is going to tell me how to run my business." Clearly, these statements indicate the presence of barriers that require substantial efforts to overcome. In contrast to firms adopting a piecemeal approach, companies like PharmaCo and TextileCo sought the more ambitious goal of changing their autonomous cultures at the same time as they implemented ERP and modified their business processes.

In summary, although the two groups had outlined very different approaches to implementing an ERP, both groups experienced the need to implement new systems and new processes simultaneously. Both groups also experienced the need to focus attention at different points in time to either, rather than both, the technical and organizational challenges. Consequently, the distinctions between the piecemeal and concerted approaches to implementing ERP were more apparent in their stated philosophies than in their implementation practices. We concluded that the concerted group of firms was more realistic in acknowledging the tight coupling between technology and organizational change, while many firms in the piecemeal group appeared naïve in their expectation that they could easily defer attention to business process changes. We found no evidence, however, that the more realistic view of the concerted approach led to greater success in overcoming knowledge barriers.

5. DISCUSSION

5.1 The Dialectic of Organizational Learning

Taken as a whole, our findings support the idea of a basic dialectic of learning during ERP implementation. The most fundamental dialectic occurs between, on the one hand, the old knowledge embedded in business processes and practices associated with legacy systems and, on the other hand, the new business processes and practices that ERP is designed to support. Where older processes are deeply ingrained into organizational memory, they represent formidable barriers to the implementation of new knowledge associated with ERP. In many cases, organizational memory is supported by organizational structures in which division managers traditionally enjoyed great autonomy and were held accountable only for bottom-line performance. ERP tends to be associated with integrated, process-centered models of organization, and moving successfully toward such newer business and organizational models requires substantial learning. ERP systems typically require organizations to replace large portions of what they know, not only about technical infrastructures but also about business processes. Implementing new systems and/or processes can thus be described and understood as a *dialectic of learning*.

Interestingly, we did not impose the vocabulary and constructs of learning on the basic assumption that ERP-related change would involve some sort of dialectic process. Rather, our use of learning constructs was drawn directly from the interview notes, which contained numerous references to learning, learning curves, and knowledge. These were mentioned not only in the context for formal training but also to describe the overall process of ERP implementation. Moreover, frequent reference to the dialectical relationship between the way things were and the way things were going to be surfaced in most of the interviews.

We position the theory at the organizational level because the issues discussed in the interviews clearly transcended individual learning. Although people did have to make individual adjustments to cope with the challenges of ERP's technical complexity and implications for business practice, learning was not concentrated at the individual level. Rather, the structures and processes of entire divisions needed to change, and references to cultural change captured the scope of the learning required at the organizational level. Caches of organizational memory formerly guarded by division managers become transparent in the world of ERP, and enduring assumptions about responsibility, accountability, and the shared understandings about what it takes to succeed are all challenged. In addition, ERP implementations challenge established assumptions about the role of IT and how it is implemented. Whereas most firms had once built information systems around the requirements of their existing operational processes, most were concluding that big packages sometimes demanded that business processes adapt to assumptions built into the software. To adjust to such new demands, clearly a large amount of organizational learning must take place.

5.2 Overcoming ERP Knowledge Barriers

The firms in our sample used a combination of means to overcome knowledge barriers associated with ERP implementation. To deal with the knowledge barriers connected with ERP configuration, they used core teams and consultants. To overcome knowledge barriers associated with the assimilation of new work processes, firms relied on formal training and incremental pacing.

Core teams acted as the primary force promoting change in the dialectic process of learning. The effectiveness of core teams depended on their size, representation, and their ability to avoid turnover of key members. Core teams that stayed together and were motivated by incentives to finish the project were very instrumental to overcoming knowledge barriers erected by unmotivated users. Not only did core teams become a key repository of new knowledge, but they

also helped to distribute knowledge throughout organizations as they came into contact with user areas.

Sustaining an effective core team is not easy. As repositories of ERP knowledge, members of core teams also become valuable to other organizations, especially consulting companies, which regularly extend lucrative offers that could triple compensation for an ERP-knowledgeable person. To prevent this sort of “brain drain,” firms in our sample embarked on programs to keep good people in place. Such programs might incorporate financial packages that include bonuses and ownership options for good performance.

Consultants operated as external intermediaries who facilitated organizational learning by bringing in external knowledge (Attewell, 1992; Robey *et al.*, 2000). However, the most successful firms in our sample limited their dependence on external consultants and took measures to ensure the transfer of external knowledge to the organization. Although the consultants’ role was key, that role had to be carefully managed by the client firm. Firms that were less successful in the management of their consultant relationships made one of two mistakes: they were either too dependent on consultants’ advice or they distrusted them. Because ERP technology is so new and complex, it is difficult for a company to embark on such an endeavor without external knowledge. However, effective use of consulting requires a firm to remain in control of the consultant-client relationship.

Formal training is an obvious choice for overcoming knowledge barriers (Bingi, *et al.*, 1999), but several of the firms in our sample spent very little on training. These same firms experienced the most difficulty in getting users to assimilate change. Other firms spent as much as 20 percent of their project budgets on training. It was also important to have training address broader change management issues and teach the concepts of process-orientation rather than focus strictly on software procedures. Previous research confirms the importance of conceptual training in addition to procedural training (Sahay and Robey, 1996). Many firms in our sample learned about this distinction painfully when they realized that their employees knew how to navigate the ERP system but they had not assimilated the basic concepts of integration and process-orientation.

An incremental approach to implementing an ERP also proved to be an effective means to overcoming the knowledge barriers associated with the assimilation of new business processes. With this approach, project participants and users have time to recover from the stress and strain of implementing an ERP, therefore diminishing the risk of mental and physical burnout. An incremental strategy to implementing ERP requires breaking up of the implementation effort into smaller pieces, thereby providing organizational members with time to assimilate the new process. Firms using an incremental strategy used different tactics: implementing in one site at a time, limiting the initial number of modules to implement, using parallel systems, and upgrading the package in small increments. Firms that have used these tactics thought that they were helpful in facilitating the assimilation of new business processes.

Our findings also showed that firms differed in the way that they approached ERP implementation. Most of the firms we studied adopted a piecemeal approach, which focused on implementing a plain vanilla version of the software first. Once the ERP was in place, most of these firms planned to deal later with the issue of transforming their business processes. Although this approach was adopted to separate the two types of learning requirements, vanilla versions required some business processes to change immediately. Thus, firms seeking the piecemeal approach were unable to execute it as they imagined. It was also unclear if those firms who focused on the technology first would be able to sustain their efforts when the process issues were dealt with “in the future.” Many respondents were candidly doubtful that the business changes

would indeed follow the ERP implementation, citing the resistant organizational cultures out in the operating divisions. Having expended effort to overcome the configuration knowledge barriers, these firms may not have had sufficient resources left to overcome the more formidable barriers associated with user acceptance.

Firms adopting a concerted approach to ERP implementation sought to change their business processes while they were implementing ERP. Although this increased the learning challenge, these firms were more likely to report full transformations rather than wait for the future. Miller and Friesen (1982) found that concerted change was more effective than piecemeal change because it confronted potential sources of resistance and forced issues rather than leaving them unaddressed. They acknowledged that organizations are complex entities that are by no means infinitely malleable, and that “many piecemeal structural changes have extensive and often negative repercussions because of the tight interdependencies among organizational parts” (Miller and Friesen, 1984: 219).

These findings imply that firms implementing ERP may not have the luxury to proceed in piecemeal fashion, even though many of them tried. Concerted change is practically forced upon most firms by virtue of ERP’s integrated nature; old business processes simply cannot be performed on new software. Moreover, firms adopting either approach also faced a future with ERP upgrades and new software releases (Glass, 1998), and few firms regarded their implementation as “complete” simply because the installed version was working.

6. CONCLUSION

This research has significant implications for firms that have implemented or are about to implement ERPs. It highlights two categories of knowledge barriers that firms are likely to encounter: configuration and assimilation knowledge barriers. The configuration challenges demand a core team that is carefully selected, motivated with incentives, and empowered to act, as well as an effectively managed consulting relationship. The assimilation challenges demand intensive employee education and appear to be more effective with incremental implementation plans. Moreover, firms differ in their implementation approach, some choosing a piecemeal approach and others a concerted approach. Despite these findings, our study provides at least as many questions as it provides answers. Future research may seek answers to questions about additional mechanisms for overcoming knowledge barriers, the dynamics of organizational learning, and the effectiveness of ERP-related organizational changes.

In a recent review of information technology and organizational learning, Robey *et al.* (2000) identified action research and situated learning as two means for overcoming knowledge barriers in addition to formal training and the use of consultant intermediaries. Action research would seem to have potential applicability to the problem of increasing learning during ERP implementation (Argyris and Schön, 1996). The goals of action research—to provide an empirically based and scientifically sound basis for improving an organization’s practices—would seem consistent with the objective of improving ERP implementation. Indeed, many of the companies in our sample referred to preparation of business cases and establishment of sets of metrics to assess their own success with ERP that could have been used in an action research program. Whether facilitated by internal or external “scientists,” action research could potentially contribute valuable knowledge to organizations both engaged in a specific ERP implementation and learning vicariously from others’ experiences.

Learning situated in social contexts, or communities of practice, is another means for overcoming knowledge barriers. In contrast to formal training, situated learning relies upon participation in a community of practice in which novice members learn by observing and listening to more

experienced participants. Because our study relied on interviews with senior executives, we had no direct access to the phenomenon of situated learning. However, some companies reported plans to distribute members of their core teams into user groups, where they would play the role of “super users,” passing on valuable knowledge about working with ERP. Future research might usefully take an ethnographic approach to studying how knowledge about ERP is communicated within communities of users. Such a study would probably reveal not only how ERP knowledge barriers are overcome but also how users creatively avoid ERP consequences that disadvantage them.

The dynamics of learning is another area where future research may be required (Robey *et al.*, 2000). Knowledge barriers eventually are overcome; still, the dynamics of organizational learning always continue. Research suggests that organizations modify their uses of information technology as they gain experience with them, but that progressive modifications and incremental improvements are not spread evenly over time (Gaimon, 1997). Rather, organizations adapt to technologies during brief periods following their introduction or later in response to later breakdowns or disruptions (Tyre and Orlikowski, 1994). Once these “windows of opportunity” are closed, learning is likely to stop as new routines become established. These findings from previous research suggest that respondents in this study may be overly optimistic about the long-term outcomes of the ERP implementations. None of the 13 firms from our sample displayed any sense of mastery over ERP following implementation. Instead, most firms believed it would take years to assimilate ERP technology. Further research is needed to explore the inconsistency in their expectations with findings from related research.

The dynamic of learning also varies according to the implementation approach chosen by a firm. To illustrate, the learning process of the firms that adopted a piecemeal approach was extended over a rather long period of time. Indeed, many of these firms did not necessarily avoid the need to reengineer, but rather temporarily accepted the processes embedded in the common vanilla version of the software, and planned for later reengineering of their processes. Initially, these firms concentrated on system implementation and delayed the redesign of their processes. Therefore, their learning process is spread over a much longer time period than the firms within the concerted change group, who chose to tackle both system and processes simultaneously. Markus, Tanis and van Fenema (2000) discussed this issue in their treatment of the “technical” and “strategic” levels of implementation and concluded that it is advisable to plan an implementation at the strategic level before proceeding to the technical level. In practice, however, “the sheer size and scale of such implementations may encourage organizations to tackle the layers independently, contributing to many failures and partial successes of these complex business and technical projects” (Markus *et al.*, 2000: 42). By tackling the technical challenge before strategic challenges, piecemeal firms may believe they are adopting a less risky approach because they can learn incrementally. However, firms pursuing a concerted change approach appear to be more realistic with respect to the demands of ERP implementation.

We have not addressed the issue of whether ERPs are effective matches for organizations because that issue is beyond the bounds of our inquiry and our data. Our data do suggest that firms adopted ERP in good faith to solve real problems that they were facing. However, our data include expressions of doubt about the value of ERP for solving particular business problems. Several respondents expressed concerns about the loss of functionality in ERP, but it is beyond the limits of our data to verify whether such concerns were valid. Certainly, ERP solutions removed some functionality associated with legacy systems, but that may have been desirable for firms seeking greater integration. Although, the present study does not focus on such concerns, they should be addressed in future research.

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